

WHAT IS CLAIMED IS:

1. A trabecular shunting device that is implantable within an eye, said device comprising:

an inlet section having at least one inlet lumen;

a flow-restricting member within the at least one inlet lumen, said flow-restricting member being configured to prevent at least one component of blood from passing through the flow-restricting member;

an outlet section having a first outlet end and a second outlet end, said outlet section having at least one outlet lumen that opens to at least one of the first and second outlet ends; and

a middle section having at least one middle lumen, said middle section being attached to said outlet section between the first and second outlet ends, said at least one middle lumen being in fluid communication with both said at least one outlet lumen and said at least one inlet lumen;

wherein the device is configured to permit fluid entering said at least one inlet lumen to pass through the flow-restricting member, enter said at least one middle lumen, pass into said at least one outlet lumen, and then exit the outlet section through at least one of said first and second outlet ends.

2. The device of Claim 1, wherein said outlet section is flexible.

3. The device of Claim 1, wherein said middle section is coextensive with said inlet section.

4. The device of Claim 1, wherein said middle section is adjustable in position relative to at least one of said inlet section and said outlet section.

5. The device of Claim 1, wherein said outlet section has a radius of curvature which ranges between about 4 millimeters and about 10 millimeters.

6. The device of Claim 1, wherein a longitudinal axis of the outlet section forms an angle with a longitudinal axis of the middle section, said angle being between about 30 degrees and about 150 degrees.

7. The device of Claim 1, wherein a longitudinal axis of the middle section forms an angle with a longitudinal axis of the inlet section, said angle being between about 20 degrees and about 150 degrees.

8. The device of Claim 1, wherein a junction between said inlet section and said middle section comprises a circumferential ridge, wherein a distance between the circumferential ridge and a junction between the middle section and said outlet section is between about 100 micrometers and about 300 micrometers.

9. The device of Claim 1, wherein said outlet section further comprises at least one side opening that is in fluid communication with said lumen of the outlet section.

10. The device of Claim 1, wherein said outlet section further comprises at least one protuberance that projects from an exterior surface of the outlet section.

11. The device of Claim 1, wherein said outlet section further comprises at least one spur that projects from an exterior surface of the outlet section.

12. The device of Claim 1, wherein said outlet section comprises an elongate trough that is in fluid communication with the lumen of said middle section.

13. The device of Claim 1, wherein said inlet section has an exterior diameter ranging between about 30 micrometers and about 500 micrometers.

14. The device of Claim 1, wherein the lumen within said inlet section has a diameter between about 20 micrometers and about 250 micrometers.

15. The device of Claim 1, wherein said middle section has an exterior diameter between about 30 micrometers and about 500 micrometers.

16. The device of Claim 1, wherein the lumen within said middle section has a diameter between about 20 micrometers and about 250 micrometers.

17. The device of Claim 1, wherein said outlet section has an exterior diameter between about 30 micrometers and about 500 micrometers.

18. The device of Claim 1, wherein the lumen within said outlet section has a diameter between about 20 micrometers and about 250 micrometers.

19. The device of Claim 1, wherein said outlet section has a longitudinal length between about 0.05 centimeters and about 10 centimeters.

20. The device of Claim 1, wherein said outlet section and said lumen within the outlet section have a generally ovoid cross-section.

21. The device of Claim 1, wherein said device is coated with at least one polymer film that contains at least one pharmaceutical substance, said polymer film permitting a delivery of a quantity of the pharmaceutical substance to ocular tissues over time.

22. The device of Claim 21, wherein said delivery is activated by incidence of an electromagnetic field.

23. The device of Claim 22, wherein said electromagnetic field arises due to Nuclear Magnetic Resonance (NMR)

24. The device of Claim 22, wherein said electromagnetic field arises due to Magnetic Resonance Imaging (MRI)

25. The device of Claim 22, wherein said electromagnetic field arises due to short range RF.

26. The device of Claim 21, wherein said delivery is activated by ultrasound waves.

27. The device of Claim 1, wherein said device is made of a material comprising at least one pharmaceutical substance admixed with a polymer substrate.

28. The device of Claim 27, wherein said polymer substrate is selected from the group consisting of poly(lactic acid), poly(ethylene-vinyl acetate), poly(lactic-co-glycolic acid), poly(D,L-lactide), poly(D,L-lactide-co-trimethylene carbonate), collagen, heparinized collagen, poly(caprolactone), poly(glycolic acid), and copolymer.

29. The device of Claim 1, wherein said device is made of a material comprising at least one pharmaceutical substance admixed with a biodegradable substrate, wherein said biodegradable substrate is selected from the group consisting of poly(lactic acid), poly(ethylene-vinyl acetate), poly(lactic-co-glycolic acid), poly(D,L-lactide), poly(D,L-lactide-co-trimethylene carbonate), collagen, heparinized collagen, poly(caprolactone), poly(glycolic acid), and copolymer.

30. A method of treating glaucoma, said method comprising:  
providing at least one pharmaceutical substance incorporated into a trabecular shunting device;

implanting the trabecular shunting device within a trabecular meshwork of an eye such that a first end of the trabecular shunt is positioned in an anterior chamber of the eye while a second end is positioned in a Schlemm's canal, wherein the first and second ends of the trabecular shunting device establish a fluid communication between the anterior chamber and the Schlemm's canal; and

allowing the shunting device to release a quantity of said pharmaceutical substance into the eye.

31. The method of Claim 30, wherein said device releases said pharmaceutical substance into the trabecular meshwork.

32. The method of Claim 30, wherein said pharmaceutical substance comprises Imidazole antiproliferative agents.

33. The method of Claim 30, wherein said pharmaceutical substance comprises quinoxalines.

34. The method of Claim 30, wherein said pharmaceutical substance comprises phosphonylmethoxyalkyl nucleotide analogs and related nucleotide analogs.

35. The method of Claim 30, wherein said pharmaceutical substance comprises potassium channel blockers.

36. The method of Claim 30, wherein said pharmaceutical substance comprises synthetic oligonucleotides.

37. The method of Claim 30, wherein said pharmaceutical substance comprises Transforming Growth Factor-beta (TGF-beta).

38. The method of Claim 30, wherein said pharmaceutical substance comprises 5-[1-hydroxy-2-[2-(2-methoxyphenoxy)ethylamino]ethyl]-2-methylbenzenesulfonamide.

39. The method of Claim 30, wherein said pharmaceutical substance comprises guanylate cyclase inhibitors.

40. The method of Claim 39, wherein the guanylate cyclase inhibitor is selected from the group consisting of methylene blue, butylated hydroxyanisole, and N-methylhydroxylamine.

41. The method of Claim 30, wherein said pharmaceutical substance comprises 2-(4-methylaminobutoxy) diphenylmethane.

42. The method of Claim 30, wherein said pharmaceutical substance comprises a combination of apraclonidine and timolol.

43. The method of Claim 30, wherein said pharmaceutical substance comprises cloprostenol analogs or fluprostenol analogs.

44. The method of Claim 30, wherein said pharmaceutical substance comprises an ophthalmic composition that provides a sustained release of a water soluble medicament, said water soluble medicament comprising a crosslinked carboxy-containing polymer, a sugar, and water.

45. The method of Claim 30, wherein said pharmaceutical substance comprises a non-corneotoxic serine-threonine kinase inhibitor.

46. The method of Claim 30, wherein said pharmaceutical substance comprises a composition of non-steroidal glucocorticoid antagonist.

47. The method of Claim 30, wherein the pharmaceutical substance comprises a prostaglandin analog or a derivative thereof.

48. A method of regulating aqueous humor outflow within an eye, said method comprising:

creating an incision in a trabecular meshwork of the eye, said incision being substantially parallel with a circumference of a limbus of the eye;

inserting an outlet section of a trabecular shunting device through the incision into Schlemm's canal such that the outlet section resides within Schlemm's canal while an inlet section of the trabecular shunting device resides in the anterior chamber; and

initiating an outflow of aqueous humor from the anterior chamber through the trabecular shunting device into Schlemm's canal.

49. The method of Claim 48, wherein said trabecular shunting device is coated with at least one polymer film that contains at least one pharmaceutical substance, said polymer film permitting a delivery of a quantity of said pharmaceutical substance to ocular tissues over time.

50. The method of Claim 49, wherein said delivery is activated by incidence of an electromagnetic field.

51. The method of Claim 50, wherein said electromagnetic field arises due to Nuclear Magnetic Resonance (NMR).

52. The method of Claim 50, wherein said electromagnetic field arises due to Magnetic Resonance Imaging (MRI).

53. The method of Claim 50, wherein said electromagnetic field arises due to short range RF.

54. The method of Claim 49, wherein said delivery is activated by incidence of ultrasound waves.

55. The method of Claim 48, wherein said trabecular shunting device comprises at least one pharmaceutical substance admixed with a polymer substrate.

56. The method of Claim 55, wherein said polymer substrate is selected from the group consisting of poly(lactic acid), poly(ethylene-vinyl acetate), poly(lactic-co-glycolic acid), poly(D,L-lactide), poly(D,L-lactide-co-trimethylene carbonate), collagen, heparinized collagen, poly(caprolactone), poly(glycolic acid), and copolymer.

57. The method of Claim 48, wherein said trabecular shunting device comprises at least one pharmaceutical substance admixed with a biodegradable substrate, wherein said biodegradable substrate is selected from the group consisting of poly(lactic acid), poly(ethylene-vinyl acetate), poly(lactic-co-glycolic acid), poly(D,L-lactide), poly(D,L-lactide-co-trimethylene carbonate), collagen, heparinized collagen, poly(caprolactone), poly(glycolic acid), and copolymer.

58. The method of Claim 48, wherein said incision is made at an angle relative to the circumference of the limbus.

59. The method of Claim 48, wherein said outlet section of the trabecular shunting device is in fluid communication with at least one aqueous collector channel.

60. The method of Claim 48, wherein said outlet section of the trabecular shunting device is in fluid communication with at least one aqueous vein.

61. The method of Claim 48, wherein said outlet section of the trabecular shunting device is in fluid communication with at least one episcleral vein.

62. A method of regulating intraocular pressure within an eye, said method comprising:

making an incision passing into a trabecular meshwork of said eye, said incision oriented lengthwise substantially parallel with a circumference of a limbus, wherein said incision establishes a fluid communication between an anterior chamber and Schlemm's canal of said eye;

implanting a trabecular shunting device through said incision such that an outlet section of the trabecular shunting device resides within Schlemm's canal and an inlet section of the trabecular shunting device resides within the anterior chamber; and

establishing a fluid transfer from the anterior chamber through the trabecular shunting device into Schlemm's canal.

63. The method of Claim 62, wherein said trabecular shunting device is coated with at least one polymer film that contains at least one pharmaceutical substance, said polymer film delivering a quantity of said pharmaceutical substance to ocular tissues.

64. The method of Claim 63, wherein said delivery is activated by incidence of an electromagnetic field.

65. The method of Claim 63, wherein said delivery is activated by incidence of ultrasound waves.

66. The method of Claim 62, wherein said trabecular shunting device comprises at least one pharmaceutical substance admixed with a polymer substrate.

67. The method of Claim 66, wherein said polymer substrate is selected from the group consisting of poly(lactic acid), poly(ethylene-vinyl acetate), poly(lactic-co-glycolic acid), poly(D,L-lactide), poly(D,L-lactide-co-trimethylene carbonate), collagen, heparinized collagen, poly(caprolactone), poly(glycolic acid), and copolymer.

68. The method of Claim 62, wherein said trabecular shunting device comprises at least one pharmaceutical substance admixed with a biodegradable substrate, wherein said biodegradable substrate is selected from the group consisting of poly(lactic acid), poly(ethylene-vinyl acetate), poly(lactic-co-glycolic acid), poly(D,L-lactide), poly(D,L-lactide-co-trimethylene carbonate), collagen, heparinized collagen, poly(caprolactone), poly(glycolic acid), and copolymer.

69. The method of Claim 62, wherein said incision is performed lengthwise at an angle relative to the circumference of the limbus.

70. The method of Claim 62, wherein said outlet section of the trabecular shunting device is in fluid communication with at least one aqueous collector channel.

71. The method of Claim 62, wherein said outlet section of the trabecular shunting device is in fluid communication with at least one aqueous vein.

72. The method of Claim 62, wherein said outlet section of the trabecular shunting device is in fluid communication with at least one episcleral vein.

73. An apparatus for implanting a trabecular shunting device within an eye, said apparatus comprising:

a syringe portion;

a cannula portion having proximal and distal ends, said distal end of said cannula portion attached to said syringe portion, said cannula portion further comprising a first lumen and at least one irrigating hole, said hole disposed between said proximal and distal ends of the cannula portion, said irrigating hole being in fluid communication with the lumen; and

a holder comprising a second lumen for holding the trabecular shunting device, wherein a distal end of the second lumen opens to said distal end of the cannula portion, and a proximal end of the second lumen is separated from said first lumen of the cannula portion;

wherein said holder holds the trabecular shunting device during implantation of said device within the eye, and said holder releases the trabecular shunting device when a practitioner activates deployment of said device.

74. The apparatus of Claim 73, wherein said cannula portion has a size ranging between about 16 gauge and about 40 gauge.

75. The apparatus of Claim 73, wherein said cannula portion has a size of about 30 gauge.

76. The apparatus of Claim 73, wherein said cannula portion has at least one lumen which is in fluid communication with said irrigating hole and with said holder.

77. A method of implanting a trabecular shunting device within an eye, said method comprising:



creating a first incision in a cornea on a first side of the eye, said first incision passing through the cornea into an anterior chamber of the eye;

passing an incising device through the first incision and moving a distal end of the incising device across the anterior chamber to a trabecular meshwork residing on a second side of the eye;

using said incising device to create a second incision, said second incision being in the trabecular meshwork, said second incision passing from the anterior chamber through the trabecular meshwork into a Schlemm's canal;

inserting said trabecular shunting device into a distal space of a delivery applicator, said delivery applicator comprising a cannula portion having a distal end and a proximal end attached to a syringe portion, said cannula portion having at least one lumen and at least one irrigating hole, said irrigating hole disposed between proximal and distal ends of the cannula portion, wherein said irrigating hole is in fluid communication with the at least one lumen, said distal space comprising a holder that holds the trabecular shunting device during delivery and releases the trabecular shunting device when a practitioner activates deployment of the device;

advancing said cannula portion and said trabecular shunting device through said first incision, across the anterior chamber and into said second incision, wherein an outlet section of the trabecular shunting device is implanted into Schlemm's canal while an inlet section of the trabecular shunting device remains in fluid communication with the anterior chamber; and

releasing said trabecular shunting device from said holder of the delivery applicator.

78. The method of Claim 77, wherein said advancing comprises moving said delivery applicator and said trabecular shunting device across the anterior chamber under gonioscopic guidance.

79. The method of Claim 77, wherein said advancing comprises moving said delivery applicator and said trabecular shunting device across the anterior chamber under microscopic guidance.

80. The method of Claim 77, wherein said advancing comprises moving said delivery applicator and said trabecular shunting device across the anterior chamber under endoscopic guidance.

81. The method of Claim 77, wherein said first incision has a surface length which is smaller than about 1.0 millimeters.

82. The method of Claim 77, wherein said first incision is self-sealing.

83. A method of treating glaucoma, said method comprising:

providing at least one pharmaceutical substance incorporated into a trabecular shunting device at about a middle section of the device;

implanting said trabecular shunting device within a trabecular meshwork of an eye such that said middle section is configured substantially within said trabecular meshwork, said shunting device having a first end positioned in an anterior chamber of said eye while a second end is positioned inside a Schlemm's canal, wherein the first and the second ends of said trabecular shunting device establish a fluid communication between said anterior chamber and said Schlemm's canal; and

allowing said middle section of said trabecular shunting device to release a quantity of said pharmaceutical substance into said trabecular meshwork.

84. The method of Claim 83, wherein said pharmaceutical substance comprises a drug adapted for neutralizing a toxic metabolic byproduct within mitochondria of cells within said trabecular meshwork.

85. The method of Claim 83, wherein said pharmaceutical substance comprises a stabilizing drug adapted for effecting mitochondrial stability of cells within said trabecular meshwork.